REMARKS

The office action of November 20, 2003 has been reviewed and its contents carefully noted. Reconsideration of this case, as amended, is requested. Claims 1-14, 16-73 and 85-89 and 91-95 remain in this case, claims 93-95 being added, claims 1, 3, 5, 7-13, 16-17, 29, 40, 47, 69 and 91 being amended and claims 15 and 74-84 being cancelled by this response. The Applicants reserve the right to pursue claims 74-84 and claim 90 (which was cancelled in an earlier response) in one or more divisional applications.

The numbered paragraphs below correspond to the numbered paragraphs in the Office Action.

Restriction Requirement

1. The Applicants acknowledge that the Examiner has made the restriction requirement final.

Objection to the Drawings

2. The drawings were objected to, because the Examiner stated that they did not show every feature of the invention specified in the claims. Specifically, the Examiner stated that neither the coating nor the optical fiber was shown in the figures. Figures 29-32 have been added to overcome this objection.

More specifically, Figure 29 has been added to show the coating claimed in claim 86, and a description of the Figure has been added to the specification. This figure is fully supported by the specification and claim 86, as filed. "For example, it is possible to cover at least one side surface of a tilted cavity by a single-layer or a multiple-layer coating. Such coverage modifies transmission of light through the side surface from the tilted cavity. By varying a number of layers in the coating, their thickness and refractive indices, it is possible to control the light output in the lateral direction". (present application, page 32, lines 5-9, as filed) No new matter has been added.

Figures 30-32 have been added to show the optical fiber claimed in claims 87-89. Descriptions of these figures have been added to the specification. These figures are fully supported by the specification (present application, page 31, lines 19-25; page 32, lines 10-14, as

filed) and claims 87-89, as filed. No new matter has been added. Reconsideration and withdrawal of the objection is respectfully requested.

Objection to the Claims

4. The Examiner quoted MPEP 608.01(n) regarding claim numbering. However, it appears that this objection was deleted by the Examiner's supervisor. A telephone call between the Applicants' agent and the Examiner on November 25, 2003 confirmed that this objection has been removed from the office action and no response by the Applicants is necessary.

Rejections under 35 U.S.C. §112

6. Claims 1-73, 85-89, 91 and 92 were rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants respectfully disagree.

7. Claims 1-73, 85-89, 91 and 92 were rejected as being incomplete for omitting essential elements, such omission amounting to a gap between the elements. The Applicants respectfully disagree.

"A claim which omits matter disclosed to be essential to the invention as described in the specification or in other statements of record may be rejected under 35 U.S.C. 112, first paragraph, as not enabling.... Such essential matter may include missing elements, steps or necessary structural cooperative relationships of elements described by the applicant(s) as necessary to practice the invention." (M.P.E.P. 2172.01).

Regarding claim 1, there is no gap between the elements claimed. Amended claim 1 reads: "a) a bottom reflector; b) a top reflector; and c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself." The amendment is fully supported by the specification, as filed, on page 3, lines 7-9; page 8, lines 27-29; and page 30, lines 1-3, and claims 74 and 79, as filed. These three elements are all that is required to create the semiconductor laser of the present invention. They

are clearly interrelated. Specifically, the cavity is **located between the bottom reflector and the top reflector** and the active region is **located within the cavity**.

In support of his rejection, the Examiner states that the omitted elements are: substrate, current spreading layers, metal contacts, the bias, undoped or weakly doped confinement layers, side mirrors and the subject matter presented in the specification on page 9, lines 9-19 (see present office action dated November 20, 2003, page 5).

However, the claim is written as "comprising" the elements of claim 1. This term does not preclude other elements of the laser. The specification does not state that any of the elements listed by the Examiner are "essential to the invention".

The specification section cited by the Examiner is contrary to the Examiner's rejection. This section discusses the cavity (which is found in claim 1) and the mirrors (the bottom and top reflectors, also found in claim 1). "If the cavity comprises at least two layers having different refractive indices, the resonant conditions in both materials stabilize both the wavelength of emitted light and the tilt angle of the optical mode. Alternatively, wavelength stabilization is realized if the cavity is just a single layer surrounded by multilayered interference mirrors. Resonant conditions in both the cavity and the layer of the multilayered mirror having a different refractive index from that of the cavity stabilize both the wavelength of emitted light and the tilt angle of the optical mode. In another embodiment, the optical mode is used to exhibit the total internal reflection at the boundaries between the two semiconductor layers. The interplay between the radiative losses through the bottom and the top mirror, on the one hand, and through the side surface, on the other hand, stabilizes the wavelength of emitted light." (present application, page 9, lines 9-19). The Applicants are claiming the invention. Since the laser comprises these elements, it may also include additional elements (which are additionally claimed in dependent claims).

The Applicants' invention in claim 1 is an improvement on a semiconductor laser. The essential elements of the **invention** are found in claim 1 and this is all that is required by 35 U.S.C. 112.

For example, if the Applicants invented an improved grass shoot for a lawn mower, they could claim a lawn mower comprising an improved grass shoot. It would not be necessary to claim the wheels or other components of the lawn mower in order to get a patent on their invention of an improved grass shoot for the lawn mower. Similarly, here the Applicants have included all of the essential elements of the invention in claim 1. Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

Claims 2-73, 85-89 and 93-95, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 2-73, and 85-89 is respectfully requested.

Regarding claim 91, there is no gap between the elements claimed. The semiconductor of claim 91 includes "a) a bottom reflector; b) a top reflector; and c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself." The amendment is fully supported by the specification on page 3, lines 7-9; page 8, lines 27-29; and page 30, lines 1-3, and claims 74 and 79, as filed. These three elements are all that is required to practice the present invention. They are clearly interrelated. Specifically, the cavity is **located between the bottom reflector and the top reflector** and the active region is **located within the cavity**.

In support of his rejection, the Examiner states that the omitted elements are: substrate, current spreading layers, metal contacts, the bias, undoped or weakly doped confinement layers, side mirrors and the subject matter presented in the specification on page 9, lines 9-19 (see present office action dated November 20, 2003, page 5).

However, the claim is written as "comprising" the elements of claim 1. This term does not preclude other elements of the semiconductor device. The specification does not state that any of the elements listed by the Examiner are "essential to the invention".

The specification section cited by the Examiner is contrary to the Examiner's rejection. This section discusses the cavity (which is found in claim 1) and the mirrors (the bottom and top reflectors, also found in claim 1). "If the cavity comprises at least two layers having different refractive indices, the resonant conditions in both materials stabilize both the wavelength of emitted light and the tilt angle of the optical mode. Alternatively, wavelength stabilization is realized if the cavity is just a single layer surrounded by multilayered interference mirrors. Resonant conditions in both the cavity and the layer of the multilayered mirror having a different refractive index from that of the cavity stabilize both the wavelength of emitted light and the tilt angle of the optical mode. In another embodiment, the optical mode is used to exhibit the total internal reflection at the boundaries between the two semiconductor layers. The interplay between the radiative losses through the bottom and the top mirror, on the one hand, and through the side surface, on the other hand, stabilizes the wavelength of emitted light." (present application, page 9, lines 9-19). The Applicants are claiming the invention. Since the laser comprises these elements, it may also include additional elements (which are additionally claimed in dependent claims).

The Applicants' invention in claim 91 is an improvement on a semiconductor device. The essential elements of the **invention** are found in claim 91 and this is all that is required by 35 U.S.C. 112. Reconsideration and withdrawal of the rejection of claim 91 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

8. Claims 1-73, 85-89, 91 and 92 were rejected as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants respectfully disagree.

Specifically, the Examiner stated that it "is unclear how the cavity and active region are designed such that light propagates in the cavity in a direction tilted both normal to a lateral plane and with respect to the lateral plane." (present office action dated November 20, 2003, page 5, lines 16-18).

Various embodiments of the present invention provide selectivity of the optical modes, as described in the specification from page 15, line 27 through page 22, line 26. The principle of the wavelength selectivity is illustrated in Figures 6 through 14. According to the general operation of a semiconductor laser, current is injected into an active region, when a forward bias is applied to a p–n junction. Injected current results in stimulated emission in the active region, which provides optical gain. Optical gain is provided for a plurality of optical modes, wherein the frequency, or the wavelength of light in these modes lie in a certain spectral range, and light can propagate in any direction. Light in every optical mode has losses that include external losses related to the emission out of the cavity and internal losses due to absorption. Lasing occurs in those optical modes, for which modal gain overcomes losses.

The tilted cavity semiconductor device of the present invention is designed such that the condition of minimum losses is met for a certain tilted optical mode, which propagates at a certain angle with respect to both the lateral plane and normal to the lateral plane. The conditions of the minimum losses mean a resonance, so this optical mode is called the resonant optical mode. Light in the resonant optical mode propagates in a direction tilted both with respect to a direction normal to a lateral plane and the lateral plane itself. The resonant optical mode with minimum losses is the mode in which lasing occurs. Claims 1 and 91 are clear. Therefore, reconsideration and withdrawal of the rejection of claims 1 and 91 is respectfully requested.

Dependent claims 2-73, 85-89, and 93-95, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claims 2-73, and 85-89 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

9. Claim 5 was rejected as being incomplete for omitting essential structure cooperative relationships of elements. Claim 5 has been amended to overcome this rejection.

Specifically, the Examiner stated that the omitted structural cooperative relationships were the feedback mechanism with any other structural element and the purpose of the feedback mechanism.

As amended, claim 5 now reads "the semiconductor laser of claim 4, further comprising a feedback mechanism, wherein the feedback mechanism in a vertical direction is provided by the bottom reflector and the top reflector, and the feedback mechanism in a lateral direction is provided by at least two side mirrors of the cavity." This amendment is fully supported Figures 2, 16 and 17, and the specification on page 10, lines 21-23 and page 22, line 12 through page 23, line 2, as filed. No new matter has been added. Reconsideration and withdrawal of the rejection of claim 5 is respectfully requested.

10. Claims 7 through 9 were rejected because the Examiner stated that "high" and "intermediate" are relative terms which are not defined. Although Applicants respectfully disagree, claims 93 through 95 have been added and claims 7 through 9 have been amended to overcome the rejection.

Claims 7 through 9 have been amended to define the refractive indices of the layers, which were described in the original claims as intermediate (sixth) and high (first, third, and fifth), with respect to each other. These amendments are fully supported by the claims and specification, as filed.

Regarding new claims 93 through 95, no new matter has been added. More specifically, these claims are fully supported by the specification on page 30, lines 12-20 and lines 27-30, and the claims, as filed.

Reconsideration and withdrawal of the rejection of claims 7-9 is respectfully requested.

11. Claims 10 through 13 were rejected because the Examiner stated that "high", "intermediate" and "low" are relative terms which are not defined. Although Applicants respectfully disagree, claims 93 through 95 have been added, and claims 10 through 13 have been amended to overcome this rejection.

Claims 10 through 13 have been amended to define the refractive indices of the layers, which were described in the original claims as low (second, fourth, and fifth), intermediate (sixth), and high (first and third), with respect to each other. These amendments are fully supported by the claims and specification, as filed.

Regarding new claims 93 through 95, no new matter has been added. More specifically, these claims are fully supported by the specification on page 30, lines 12-20 and lines 27-30, and the claims, as filed.

Reconsideration and withdrawal of the rejection of claims 10-13 is respectfully requested.

12. Claim 15 was rejected for omitting essential structural cooperative relationships of elements. Although Applicants respectfully disagree, claim 15 has been cancelled to further prosecution of the application. Applicants respectfully request withdrawal of the rejection.

13. Claim 29 was rejected for indefiniteness of "a current aperture". Claims 3 and 29 have been amended to overcome this rejection.

Specifically, claim 3 now recites a first current aperture located between each neighboring region of the cavity. Claim 29 recites a second current aperture located between each neighboring region of the phase control element. Reconsideration and withdrawal of the rejection of claim 29 is respectfully requested.

Claims 30-46, 64, 65 and 68, being dependent upon and further limiting claim 29, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 30-46, 64, 65 and 68 is respectfully requested.

14. Claim 40 was rejected for indefiniteness of "a current aperture". Claims 3, 29, and 40 have been amended to overcome this rejection.

Specifically, claim 3 now recites a first current aperture located between each neighboring region of the cavity. Claim 29 recites a second current aperture located between each neighboring region of the phase control element. Claim 40 includes a third current aperture

placed between each neighboring region of the power modulating element. Reconsideration and withdrawal of the rejection of claim 40 is respectfully requested.

Claims 41-46 and 48, being dependent upon and further limiting claim 40, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 41-46 and 48 is respectfully requested.

15. Claim 47 was rejected for indefiniteness for "current apertures" in the claim. Claims 3 and 47 have been amended to overcome this rejection.

Specifically, claim 3 now recites a first current aperture located between each neighboring region of the cavity. Claim 47 recites a second current aperture located between each neighboring region of the power modulating element. Reconsideration and withdrawal of the rejection of claim 47 is respectfully requested.

Claims 48-57, 66 and 67, being dependent upon and further limiting claim 47, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 48-57, 66 and 67 is respectfully requested.

16. Claim 69 was rejected for indefiniteness for "current apertures" in the claim. Claims 3 and 69 have been amended to overcome this rejection.

Specifically, claim 3 now recites a first current aperture located between each neighboring region of the cavity. Claim 69 recites a second current aperture located between between the first p-doped current spreading region and the modulating region. Reconsideration and withdrawal of the rejection of claim 69 is respectfully requested.

Claims 70-73, being dependent upon and further limiting claim 69, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 70-73 is respectfully requested.

17. Claims 87-89 were rejected because the Examiner stated it was unclear how an optical fiber provides coupling to said optical fiber.

Claim 87 reads, in part, "wherein at least one optical fiber is attached in a near field zone of an electromagnetic field in a vicinity of a side surface of the cavity thus providing coupling of a resonant optical mode of the cavity to the optical fiber". The claim is clear. The optical fiber is attached in a near field zone of an electromagnetic field in a vicinity of a side surface of the cavity. The location of the optical fiber allows for coupling of a resonant optical mode of the cavity to the optical fiber. The optical fiber is not coupled to itself; there is coupling between a resonant optical mode of the cavity and the optical fiber. Reconsideration and withdrawal of the rejection of claim 87 is respectfully requested.

Claim 88 reads, in part, "wherein at least one optical fiber is attached in a near field zone of an electromagnetic field in a vicinity of a top surface of the top reflector, thus providing coupling of a resonant optical mode of the cavity to the optical fiber". The claim is clear. The optical fiber is attached in a near field zone of an electromagnetic field on a vicinity of a side surface of the cavity. The location of the optical fiber allows for coupling of a resonant optical mode of the cavity to the optical fiber. The optical fiber is not coupled to itself; there is coupling between a resonant optical mode of the cavity and the optical fiber. Reconsideration and withdrawal of the rejection of claim 88 is respectfully requested.

Claim 89 reads, in part, "wherein at least one optical fiber is attached in a near field zone of an electromagnetic field on top of a top surface of the top reflector, thus providing coupling of a resonant optical mode of the cavity to the optical fiber". The claim is clear. The optical fiber is attached in a near field zone of an electromagnetic field on a vicinity of a side surface of the cavity. The location of the optical fiber allows for coupling of a resonant optical mode of the cavity to the optical fiber. The optical fiber is not coupled to itself; there is coupling between a resonant optical mode of the cavity and the optical fiber. Reconsideration and withdrawal of the rejection of claim 89 is respectfully requested.

18. Claim 92 was rejected because the Examiner stated that it was unclear how a photodetector comprises a cavity having an active region. Applicants respectfully disagree.

A photodetector is a semiconductor device, which, in the claim, comprises a cavity having an active region. The Applicants are unsure how this makes the claim indefinite. If the semiconductor device is a photodetector, it comprises a cavity having an active region. There is

nothing unclear about the claim. Applicants respectfully request reconsideration and withdrawal of the rejection of claim 92, and if the Examiner repeats the rejection, the Applicants request further clarification on how the claim is unclear.

Rejections under 35 U.S.C. §102

20. Claims 1-14, 19-23, 63, 85, 91 and 92 were rejected under 35 U.S.C. 102(b) as being anticipated by Applicant's Admitted Prior art. Applicants respectfully disagree with the rejection.

Figure 1 is described in the present application:

"A prior art surface emitting laser, or more specifically, a vertical cavity surface emitting laser (VCSEL), is shown in Fig. 1. In a surface emitting laser, an active region is generally put into a cavity. An undoped or weakly doped active region is surrounded by n- and p- contact layers, which are generally surrounded by mirrors. The structure is grown epitaxially on a substrate (10). Bragg reflectors are used for the bottom mirror (102). The rest of the VCSEL is an active element.

A current aperture (13) separates an n-doped current spreading layer (14) having a first metal contact (15), from the weakly doped confinement layers (16) surrounding the active region (17). A second current aperture (13) separates the weakly doped confinement layer (16) from a p-doped current spreading layer (18) having a second metal contact (19). The n-doped current spreading layer (14) sits directly on top of the bottom mirror (102). The active element operates under forward bias (11). The active region (17) generates light. Confinement layers (16) serve to provide electronic confinement for the carriers trapped in the active region. The light comes out (112) through the top mirror (110).

The substrate (10) can be formed from any III-V semiconductor material or III-V semiconductor alloy, e.g. GaAs, InP, GaSb. GaAs or InP are generally used depending on the desired emitted wavelength of laser radiation. The n-doped layer (14) must be formed from the material lattice-matched or nearly lattice-matched to the substrate (10), transparent to the generated light, and doped by donor impurities. The n-doped layer (14) is preferably the same material as that of the substrate (10), e.g. GaAs. Possible donor impurities include, but are not

limited to, S, Se, Te, and amphoteric impurities like Si, Ge, Sn where the latter are introduced under such technological conditions that they are incorporated predominantly into the cation sublattice and serve as donor impurities.

The p-doped layer (18) must be formed from a material, lattice-matched or nearly lattice-matched to the substrate (10), transparent to the generated light, and doped by an acceptor impurity. The p-doped layer (18) is preferably the same material as the substrate (10), e.g. GaAs. Possible acceptor impurities include, but are not limited to, Be, Mg, Zn, Cd, Pb, Mn and amphoteric impurities like Si, Ge, Sn where the latter are introduced under such technological conditions that they are incorporated predominantly into the anion sublattice and serve as acceptor impurities.

The metal contacts (15) and (19) are preferably formed from the multi-layered metal structures. Metal contacts (15) are preferably formed from structures including, but not limited to, the structure Ni-Au-Ge. Metal contacts (19) are preferably formed from structures including, but not limited to, the structure Ti-Pt-Au.

The confinement layers (16) must be formed from a material lattice-matched or nearly lattice-matched to the substrate (10), transparent to the emitted light, and undoped or weakly doped. The confinement layers are preferably formed from the same material as the substrate (10).

The active region (17) placed within the confinement layer (16) is preferably formed by any insertion, the energy band gap of which is narrower than that of the substrate (10). Possible active regions (17) include, but are not limited to, a single-layer or a multi-layer system of quantum wells, quantum wires, quantum dots, or any combination thereof. In a case of the device on a GaAs-substrate, examples of the active region (17) include, but are not limited to, a system of insertions of InAs, $In_{1-x}Ga_xAs$, $In_xGa_{1-x-y}Al_yAs$, $In_xGa_{1-x}As_{1-y}N_y$ or similar materials.

Each layer is separated from the neighboring layer by a current aperture (13) that works as a current blocking layer and can be formed from a material including, but not limited to, an Al(Ga)O layer or a proton bombardment layer.

Different designs for the bottom mirror (102) and for the top mirror (110) can be used, as described, e.g. in D.G. Deppe, *Optoelectronic Properties of Semiconductors and Superlattices* (Vol. 10, Vertical-Cavity Surface-Emitting Lasers: Technology and Applications, edited by J. Cheng and N.K. Dutta, Gordon and Breach Science Publishers, 2000, pp. 1-61). Typical designs include, but are not limited to, a multi-layered semiconductor mirror $GaAs/Ga_{1-x}Al_xAs$ for devices on GaAs substrate or a multilayered structure of a quaternary alloy $In_xGa_{1-x-y}Al_yAs$ with alternating composition for devices on an InP substrate.

A disadvantage of using this design is the need to fabricate Bragg mirrors with an extremely large number of layers because there is a very restricted choice of materials suitable to create Bragg mirror layers. All of the layers must be lattice-matched or nearly lattice matched to the substrate. For GaAs-based VCSELs, these layers are AlAs and $Ga_{1-x}Al_xAs$ alloys. For the emitted wavelength λ=0.98 μm, the difference in refractive indices between GaAs and AlAs is rather small (Δn=0.57), and about 30 periods (60 layers) are needed in a Bragg mirror to reach 99.5% reflectivity (see, e.g., U.S. Patent No. 6,154,480). For InP-based VCSELs, a suitable lattice-matched material is the alloy $Ga_{0.47}In_{0.53}As$ and corresponding quaternary alloys $In_xGa_{1-x}As_{1-y}P_y$ with the composition (x, y) obeying the relation $x = 1 - 0.47(1 - y)$ or quaternary alloys $In_xGa_{1-x--y}Al_yAs$ with the composition $x = 0.53$ and arbitrary y. The difference in refractive indices between the layers is in this case even smaller ($\Delta n \approx 0.3$), and about 100 periods (200 layers) are needed in the Bragg mirror." (present application, page 6, line 15 to page 8, line 26).

Regarding claim 1, the amended claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that **light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**." (Emphasis added). The prior art discussed with reference to Fig. 1 in the application does not include a cavity and active region designed so light propagates in the cavity in a direction <u>tilted</u> with respect to both a direction normal to the lateral plane and the lateral plane itself. Instead, for the embodiment shown in Fig. 1, light propagates within the cavity in the vertical direction, perpendicular to the pn junction plane, or perpendicular to the lateral plane of the epitaxial structure, and comes out (112) in the vertical

direction. Therefore, claim 1 is not anticipated by Applicant's admitted prior art. Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

Claims 2-14, 19-23, 63 and 85, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 2-14, 19-23, 63 and 85 is respectfully requested.

Regarding claim 91, the amended claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that **light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**" (Emphasis added). The prior art discussed with reference to Fig. 1 in the application does not include a cavity and active region designed so light in the resonant optical mode propagates in the cavity in a direction <u>tilted</u> with respect to both a direction normal to the lateral plane and the lateral plane itself. Instead, in Fig. 1, light (112) propagates within the cavity in the vertical direction, perpendicular to the pn junction plane, or perpendicular to the lateral plane of the epitaxial structure. Therefore, claim 91 is not anticipated by Applicants' admitted prior art. Reconsideration and withdrawal of the rejection of claim 91 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

21. Claims 1-15, 17, 19-23, 27, 28, 63, 85, 91 and 92 were rejected under 35 U.S.C. 102(b) as being anticipated by Lim *et al.* (5,757,837). Applicants respectfully disagree.

Regarding claim 1, the amended claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, **wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**" (Emphasis added). Lim *et al.* does not disclose

a cavity and active region designed so light propagates in the cavity in a direction tilted with respect to both a direction normal to the lateral plane and the lateral plane itself.

The Examiner points to Figs. 1, and 15-18 to support his assertion that the elements of claim 1 are disclosed in Lim *et al.* Fig. 1 "illustrates an intracavity quantum well photodetector integrated within a vertical-cavity surface emitting laser 20". (col. 3, lines 59-61). In this embodiment, "light comes out of the bottom surface 70 of the substrate 22. Thus, it is referred to as a bottom-emitting device. The device can also be designed to have light come out of the top surface.... In general, the device operates in a manner that is consistent with existing VCSEL devices.... However, in accordance with the invention, the device is operated in conjunction with the intracavity quantum well photodetector 50. That is, the intracavity quantum well photodetector 50 of the invention provides an improved photocurrent for use in a standard feedback circuit which is used to adjust the laser injection current in a standard manner." (col. 4, lines 34-37, 43-44, 50-56). Fig. 15 adds an air bridge to the structure, Fig. 16 has a ridge waveguide geometry, Fig. 17 has a buried heterostructure design, and Fig. 18 utilizes proton implantation. None of these figures disclose a device that allows laser light to propagate in a cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself.

In fact, the device in Lim *et al.* is not designed so that a resonant optical mode is selected such that light in the resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane. Instead, laser light propagates in the direction normal to the lateral plane, either through the top of the device or the bottom of the device as known in conventional vertical cavity devices (like vertical cavity surface emitting lasers (VCSELs) and vertical cavity photodetectors). The background discusses such conventional VCSELs. "A VCSEL is an injection diode laser where the **laser oscillation** and output **occur normal** to a semiconductor pn junction plane. In edge-emitting laser diodes, the laser oscillation and output occur in the semiconductor pn junction plane." (Emphasis added, col. 1, lines 22-26). This patent does not disclose laser light propagating in a cavity in a tilted direction. Therefore, claim 1 is not anticipated by Lim *et al.* Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

Claims 2-15, 17, 19-23, 27, 28, 63 and 85, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 2-15, 17, 19-23, 27, 28, 63 and 85 is respectfully requested.

Regarding claim 91, the claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that **light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**" (Emphasis added). Lim *et al.* does not disclose a cavity and active region designed so light in the resonant optical mode propagates in the cavity in a direction <u>tilted</u> with respect to both a direction normal to a lateral plane and the lateral plane itself.

The Examiner points to Figs. 1, and 15-18 to support his assertion that the elements of claim 91 are disclosed in Lim *et al.* Fig. 1 "illustrates an intracavity quantum well photodetector integrated within a vertical-cavity surface emitting laser 20". (col. 3, lines 59-61). In this embodiment, "light comes out of the bottom surface 70 of the substrate 22. Thus, it is referred to as a bottom-emitting device. The device can also be designed to have light come out of the top surface.... In general, the device operates in a manner that is consistent with existing VCSEL devices.... However, in accordance with the invention, the device is operated in conjunction with the intracavity quantum well photodetector 50. That is, the intracavity quantum well photodetector 50 of the invention provides an improved photocurrent for use in a standard feedback circuit which is used to adjust the laser injection current in a standard manner." (col. 4, lines 34-37, 43-44, 50-56). Fig. 15 adds an air bridge to the structure, Fig. 16 has a ridge waveguide geometry, Fig. 17 has a buried heterostructure design, and Fig. 18 utilizes proton implantation. None of these figures disclose a device that allows light to propagate in a cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself.

In fact, the device in Lim *et al.* is not designed so that light in the resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane. Instead, light propagates in the direction normal to the lateral plane,

as known in conventional vertical cavity devices and comes out either through the top of the device or the bottom of the device. The background discusses such conventional VCSELs. "A VCSEL is an injection diode laser where **the laser oscillation** and output **occur normal** to a semiconductor pn junction plane. In edge-emitting laser diodes, the laser oscillation and output occur in the semiconductor pn junction plane." (Emphasis added; col. 1, lines 22-26). This patent does not disclose light in a resonant optical mode propagating in a cavity in a tilted direction. Therefore, claim 91 is not anticipated by Lim *et al.* Reconsideration and withdrawal of the rejection of claim 91 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

22. Claims 1, 2, 4-13, 18-24, 58-63, 85, 91 and 92 were rejected under 35 U.S.C. 102(b) as being anticipated by Hanke *et al.* (5,973,336). Applicants respectfully disagree.

The present application is very different from Hanke *et al.* The present application addresses a wavelength–stabilized semiconductor device, while Hanke *et al.* addresses a light–emitting diode having no wavelength stabilization.

In the present invention, lasing occurs in the resonant optical mode, having minimum total losses at a certain wavelength, due to a combined effect of the cavity and the reflectors. The total losses include external losses due to emission of light out of the device, which are minimized for the active mode. On the contrary, the invention disclosed in Hanke *et al.* aims to increase the light emission of radiation out of the device for the active modes.

More specifically, Hanke *et al.* discloses a light emitting diode. A "Light emitting diode (LED) is a semiconductor diode which emits incoherent radiation. LEDs operate on the principle of spontaneous emission resulting from electron hole pair injection and *direct* recombination under forward bias.... Because of the statistical nature of the recombination process between electrons and holes, the emitted photons are in random directions; they result from spontaneous emission processes in contrast to stimulated emission."

(http://materials.usask.ca/server/kasap/Dictionary/L.html, page 3 of 6) A copy of the web page including this definition is attached.

The patent by Hanke *et al.* discloses one particular art of LEDs, "allowing radiation generated to be guided towards the side faces of the LED by means of a relatively thick waveguide comprised of a transmissive material, specifically in such a way that as many modes as possible can propagate." (Abstract). Many modes, without any wavelength stabilization, are present among the modes propagating in the waveguide of the LED disclosed by Hanke *et al.*

Hanke *et al.* increases the emission of radiation. "In order to improve the emission of radiation, an antireflecting layer 7, ... can be provided on the side face." (col. 3, lines 9–11). "The light emission can also be improved by other known measures." (col. 3, lines 12–13).

In contrast, claim 1 of the present invention discloses a semiconductor laser, which is synonymous with the terms diode laser and laser diode. A "<u>[l]aser diode</u> is a semiconductor diode which emits <u>coherent radiation</u>, in contrast to a <u>light emitting diode</u> (LED) which emits incoherent radiation. <u>Laser diodes</u> operate on the principle of <u>stimulated emission</u> resulting from electron hole pair injection and direct <u>recombination</u> under forward bias." (Emphasis added) (http://materials.usask.ca/server/kasap/Dictionary/L.html, page 1 of 6) A copy of the web page containing this definition is attached.

"All lasers use the principle of amplification of electromagnetic waves by stimulated emission of radiation. The term laser is an acronym for light amplification by stimulated emission of radiation". (Lim *et al.*, US Patent 5,757,837, col. 1, lines 31–34).

A necessary condition for stimulated emission is that "the electron and hole quasi–Fermi level separation exceed the photon energy. To achieve laser threshold, the gain must exceed the losses due to external emission plus the internal cavity losses such as free carrier absorption and scattering." (H.C. Casey, Jr., and M.B. Panish. "Heterostructure Lasers. Part A, Fundamental Properties". Academic Press, New York, p. 183). A copy of the relevant page of this reference is attached.

Amended claim 1 reads: "a semiconductor laser comprising: a) a bottom reflector; b) a top reflector; and c) a cavity located between the bottom reflector and the top reflector

comprising an active region located within the cavity, wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself."

Hanke *et al.* does not include a cavity and active region design such that any mode is selected as a resonant optical mode. Instead, Hanke *et al.* discloses light emitting diodes (LEDs) that emit incoherent radiation, which is present in a large number of optical modes. Moreover, selection of modes is not disclosed in Hanke *et al.* On the contrary, the LED is designed such that "as many modes as possible can propagate" (Abstract, line 5). The reflectivity of mirrors at the side facets, through which light comes out, are minimized to ensure an efficient extraction of light.

In contrast, in claim 1, the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself.

The resonant optical mode is selected by the condition of the minimum losses, which for the lasers of claim 1 include radiative losses due to external emission through the side facets plus the losses due to the emission of light through bottom and top reflectors. The means providing the selection of the optical modes with respect to the total losses include the particular design of multilayered interference reflectors and particular design of the cavity, as described in detail in the specification from page 15, line 27 through page 22, line 26. The wavelength selectivity is illustrated in Figures 6 through 14. Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

Claims 2, 4-13, 18-24, 58-63, and 85, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 2, 4-13, 18-24, 58-63, and 85 is respectfully requested.

Amended claim 91 reads: "a semiconductor device comprising: a) a bottom reflector; b) a top reflector; and c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region

are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself."

Hanke *et al.* does not include a cavity and active region design such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself. Instead, Hanke *et al.* discloses light emitting diodes (LEDs) that emit incoherent radiation, which is present in a large number of optical modes. Moreover, selection of modes is not disclosed in Hanke *et al.* On the contrary, the LED is designed such that "as many modes as possible can propagate" (Abstract, line 5). The reflectivity of mirrors at the side facets through which light comes out, are to be minimized to ensure an efficient extraction of light.

In contrast, in claim 91, the resonant optical mode is a tilted mode, in which light propagates within the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself.

The resonant optical mode is selected by the condition of the minimum losses, which for the devices of claim 91 include radiative losses due to external emission through the side facets plus the losses due to the emission of light through bottom and top reflectors. The means providing the selection of the optical modes with respect to the total losses include the particular design of multilayered interference reflectors and particular design of the cavity, as described in detail in the specification from page 15, line 27 through page 22, line 26. The wavelength selectivity is illustrated in Figures 6 through 14. Reconsideration and withdrawal of the rejection of claim 91 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

23. Claims 1-15, 17-23, 25, 58-63, 85, 91, and 92 were rejected under 35 U.S.C. 102(b) as being anticipated by Magnusson *et al.* (6,154,480). Applicants respectfully disagree.

A key requirement enabling the operation of the device disclosed in Magnusson *et al.* is a periodically modulated structure in a direction parallel to the surface. A crucial element of the

invention in Magnusson *et al.* is guided mode resonance (GMR) mirrors. "The new VCL can be fabricated without Bragg mirrors by replacing them with efficient diffractive (guided–mode resonance (GMR)) mirrors with much fewer layers, for example, two or three layers. (Abstract, lines 3–7).

The key feature of GMR mirrors is that the refractive index is periodically modulated in the lateral direction. "The use of GMR mirrors fundamentally provides optical power flow not only across the active medium layer but also along the active region due to diffractive coupling" (col. 2, lines 47–50). Diffractive coupling occurs due to the refractive index modulation in the lateral plane and would not occur without such modulation.

Figures illustrating the embodiments of Magnusson *et al.* show the periodic modulation. These are Guided–Mode Resonance Mirror 22 in Fig. 2, periodically modulated structure in the inset of Fig. 3, p–type GMR Grating/Mirror 22' in Fig. 5, Guided–Mode Resonance Mirrors 32 and Guided–Mode Resonance Mirrors 22 in Fig. 6, Waveguide 33 including a periodically modulated structure in the lateral plane in Fig. 7, and GMR Mirror 22'' in Fig. 8.

"FIGS. 9–13 illustrate steps for making a GMR–VCL, using GaAs as an example material system, in accordance with the present invention." (col. 3, lines 28–30). These figures show a 250 nm photoresist layer (250–300 nm grating period) in Fig. 10, a ~100 nm thick etched grating layer in Fig. 11, a periodically modulated grating layer in Fig. 12 (not marked specifically), and a periodically modulated grating layer in Fig. 13 (not marked specifically), partially etched through. Fig. 15 schematically illustrates diffraction of a vertical optical mode into a propagating leaky mode in the lateral direction, and its diffraction back. A periodic grating comprising alternating regions marked in gray and white is shown and its period Λ is explicitly marked.

Thus, a periodic grating resulting in diffraction of light in the laser mode is required in Magnusson *et al.* "The photon gain paths characteristic of the GMR–VCL device are clearly shown in FIG. 5 by the arrows 26 & 28". (col. 5, lines 23–25). The arrows 26 point to the propagation of laser light in the vertical direction through the mirror, and the arrows 28 point to the propagation of the laser light in the lateral direction due to diffraction at the GMR–mirror. Referring to FIG. 7, the patent reads "[i]n this case, both GMR gratings and the active region are

combined into a single periodic structure surrounded by appropriate waveguide 33 and the film spacer layers 35" (col. 5, lines 55–58). "As can be seen, the active region 24...has the same period as both the upper and lower GMR gratings." (col. 5, lines 62–63). "Coupled VCLs share a continuous resonant waveguide grating in the GMR mirrors." (col. 6, lines 11–13). In contrast, the present invention does not require a grating.

Magnusson *et al.* does not disclose constructing a wavelength-stabilized laser without a periodic structure in a direction in the surface plane, i.e., without a refractive index modulation in the surface plane. Distributed Bragg reflectors (DBRs) are calculated by Magnusson *et al.* to fit the vertically propagating light in the cavity. No wavelength–stabilized operation without patterning in a lateral direction is disclosed by Magnusson.

In contrast, the present invention discloses constructing a semiconductor device, in which the cavity and active region are designed such that light in the resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to the lateral plane and the lateral plane itself. This is the optical mode having minimum total losses, and the mode in which lasing occurs. The conditions of the minimum losses are met for a mode having a certain tilt angle and a certain wavelength. Thus, a wavelength-stabilized laser is constructed by a proper design of the cavity and reflectors, without any structure modulated in the surface plane.

Regarding amended claim 1, the claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, **wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**". (Emphasis added). Magnusson *et al.* does not disclose a cavity and active region designed so light propagates in the cavity in a direction tilted with respect to both a direction normal to the lateral plane and the lateral plane itself.

The Examiner points generally to Figs. 2, 5, 6 and 8-15 to support his assertion that claim 1 is anticipated by Magnusson *et al.* The Examiner does not specifically point to any portion of the patent when he states that the patent discloses the cavity and the active region being designed such that light propagates in the cavity in a direction tilted both normal to a lateral plane and with

respect to the lateral plane. (see present office action dated November 20, 2003, page 9, lines 11-13).

Figs. 2, 5, 6 and 8-15 show various embodiments of the invention of Magnusson *et al.* "The new VCLs can be fabricated without Bragg mirrors by replacing them with efficient diffractive (guided-mode resonance (GMR)) mirrors with much fewer layers...." (Abstract). As shown in Fig. 5, the light output is normal to the substrate. Nowhere does the patent disclose a cavity and an active region designed such that light propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself. Therefore, claim 1 is not anticipated by Magnusson *et al.* Reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

Claims 2-15, 17-23, 25, 58-63, and 85, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 2-15, 17-23, 25, 58-63, and 85 is respectfully requested.

Regarding amended claim 91, the claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, wherein the cavity and the active region are designed such that **light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself**" (Emphasis added). Magnusson *et al.* does not disclose a cavity and active region designed so light in a resonant optical mode propagates in the cavity in a direction <u>tilted</u> with respect to both a direction normal to the lateral plane and the lateral plane itself.

The Examiner points generally to Figs. 2, 5, 6 and 8-15 to support his assertion that claim 91 is anticipated by Magnusson *et al.* The Examiner does not specifically point to any portion of the patent when he states that the patent discloses the cavity and the active region being designed such that light propagates in the cavity in a direction tilted both normal to a lateral plane and with respect to the lateral plane. (see present office action dated November 20, 2003, page 9, lines 11-13).

Figs. 2, 5, 6 and 8-15 show various embodiments of the invention of Magnusson *et al.* "The new VCLs can be fabricated without Bragg mirrors by replacing them with efficient diffractive (guided-mode resonance (GMR)) mirrors with much fewer layers…." (Abstract). As shown in Fig. 5, the light output is normal to the substrate. Nowhere does the patent disclose a cavity and an active region designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to the lateral plane and the lateral plane itself. Therefore, claim 91 is not anticipated by Magnusson *et al.* Reconsideration and withdrawal of the rejection of claim 91 is respectfully requested.

Claim 92, being dependent upon and further limiting claim 91, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 92 is respectfully requested.

Rejections under 35 U.S.C. §103

25. Claim 16 was rejected under 35 U.S.C. 103(a) as being unpatentable over Lim *et al.* Applicants respectfully disagree. The arguments regarding the anticipation of claim 1, upon which claim 16 depends, are incorporated herein.

As discussed above, claim 1, upon which claim 16 depends, is not anticipated by Lim *et al.* Similarly, claim 1 is not obvious over Lim *et al.* Lim *et al.* does not teach or suggest a cavity and an active region designed such that light in the resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself. Therefore, claim 1 is not obvious over Lim *et al.*

Regarding claim 16, the Examiner admits that Lim *et al.* does not teach "the optical aperture being made by partial selective removal of several layers of the top reflector." (present office action dated November 20, 2003, page 10, lines 10-11). However, the Examiner continues by stating it would be an obvious matter of design choice to use any known method in the art to make an optical aperture. The Examiner provides no support for this statement. Instead, the Examiner states that "applicant has not disclosed that partial selective removal solves any stated problem or is for any particular purpose and it appears that the invention would

perform equally well with an additional layer add[ed] on top of the reflector." (present office action dated November 20, 2003, page 10, lines 13-15).

In the United States, the standard of obviousness has no relation to whether or not the elements claimed solved any stated problem or is for any particular purpose. Even if the invention would perform equally well with an additional layer added on top of the reflector (which the Applicants do not concede), that is irrelevant to whether or not claim 16 is obvious. Amended claim 16 is a dependent claim, which adds a limitation to claim 1, upon which it depends. Instead, in order for the Examiner to make a valid argument for obviousness, he must show that the reference or references, alone or in combination, teach or suggest all of the elements in the claim. The Examiner admits that Lim *et al.* does not teach or suggest the elements of claim 16.

"The deficiencies of the cited references cannot be remedied by... general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art.... With respect to core factual findings in a determination of patentability,... the... [Examiner] cannot simply reach conclusions based on its own understanding or experience - or on its assessment of what would be basic knowledge or common sense. Rather, the... [Examiner] must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 59 USPQ2d 1693, 1697 (Fed. Cir. 2001).

In addition, the Federal Circuit has held that the Examiner must identify the specific principle or objective teaching that would suggest the claimed combination. *see In re Lee*, 61 USPQ2d 1430, 1433-1435 (Fed. Cir. 2002). Unspecified common sense and common knowledge is not sufficient for obviousness. *see id.* The Patent Office is obligated to develop an evidentiary basis for its findings. *See id.*

The Examiner has not provided concrete evidence to support his assertions that partial selective removal of several layers of the top reflector is an obvious matter of design choice. Nor has he provided a specific principle or objective teaching to suggest the claimed combination of claim 16. Therefore, claim 16 is not obvious over Lim *et al.*

Claim 16, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 16 is respectfully requested.

26. Claims 16 and 26 were rejected under 35 U.S.C. 103(a) as being unpatentable over Magnusson *et al.* Applicants respectfully disagree. The arguments regarding the anticipation of claim 1, upon which claims 16 and 26 depend, are incorporated herein.

As discussed above, claim 1, upon which claims 16 and 26 depend, is not anticipated by Magnusson *et al.* Similarly, claim 1 is not obvious over Magnusson *et al.* Magnusson *et al.* does not teach or suggest a cavity and an active region designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself. Therefore, claim 1 is not obvious over Magnusson *et al.*

Regarding claim 16, the Examiner admits that Magnusson *et al.* does not teach "the optical aperture being made by partial selective removal of several layers of the top reflector." (present office action dated November 20, 2003, page 10, lines 18-19). However, the Examiner continues by stating it would be an obvious matter of design choice to use any known method in the art to make an optical aperture. The Examiner provides no support for this statement. Instead, the Examiner states that "applicant has not disclosed that partial selective removal solves any stated problem or is for any particular purpose and it appears that the invention would perform equally well with an additional layer add[ed] on top of the reflector." (present office action dated November 20, 2003, page 10, lines 21-24).

In the United States, the standard of obviousness has no relation to whether or not the elements claimed solved any stated problem or is for any particular purpose. Even if the invention would perform equally well with an additional layer added on top of the reflector (which the Applicants do not concede), that is irrelevant to whether or not claim 16 is obvious. Amended claim 16 is a dependent claim, which adds a limitation to claim 1, upon which it depends. Instead, in order for the Examiner to make a valid argument for obviousness, he must show that the reference or references, alone or in combination, teach or suggest all of the elements in the claim. The Examiner admits that Magnusson *et al.* does not teach or suggest the elements of claim 16.

"The deficiencies of the cited references cannot be remedied by... general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art.... With respect to core factual findings in a determination of patentability,... the... [Examiner] cannot simply reach conclusions based on its own understanding or experience - or on its assessment of what would be basic knowledge or common sense. Rather, the... [Examiner] must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 59 USPQ2d 1693, 1697 (Fed. Cir. 2001).

In addition, the Federal Circuit has held that the Examiner must identify the specific principle or objective teaching that would suggest the claimed combination. *see In re Lee*, 61 USPQ2d 1430, 1433-1435 (Fed. Cir. 2002). Unspecified common sense and common knowledge is not sufficient for obviousness. *see id.* The Patent Office is obligated to develop an evidentiary basis for its findings. *See id.*

The Examiner has not provided concrete evidence to support his assertions that partial selective removal of several layers of the top reflector is an obvious matter of design choice. Nor has he provided a specific principle or objective teaching to suggest the claimed combination of claim 16. Therefore, claim 16 is not obvious over Magnusson *et al.*

Claim 16, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 16 is respectfully requested.

Regarding claim 26, the Examiner admits that Magnusson *et al.* does not teach a grating fabricated above the top reflector, where the grating provides a distributed feedback in a lateral direction. However, the Examiner continues by stating it would be an obvious matter of design choice to any known element in the art that provides a distributed feedback in a lateral direction. The Examiner provides no support for this statement. Instead, the Examiner states that "applicant has not disclosed that a grating fabricated above the top reflector solves any stated problem or is for any particular purpose and it appears that the invention would perform equally well with the top reflector being partially etched." (present office action dated November 20, 2003, page 11, lines 5-7).

In the United States, the standard of obviousness has no relation to whether or not the elements claimed solved any stated problem or is for any particular purpose. Even if the invention would perform equally well with the top reflector being partially etched (which the Applicants do not concede or deny), that is irrelevant to whether or not claim 26 is obvious. Claim 26 is a dependent claim, which adds a limitation to claim 1, upon which it depends.

In order for the Examiner to make a valid argument for obviousness, he must show that the reference or references, alone or in combination, teach or suggest all of the elements in the claim. The Examiner admits that Magnusson *et al.* does not teach or suggest the elements of claim 26.

"The deficiencies of the cited references cannot be remedied by... general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art.... With respect to core factual findings in a determination of patentability,... the... [Examiner] cannot simply reach conclusions based on its own understanding or experience - or on its assessment of what would be basic knowledge or common sense. Rather, the... [Examiner] must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 59 USPQ2d 1693, 1697 (Fed. Cir. 2001).

In addition, the Federal Circuit has held that the Examiner must identify the specific principle or objective teaching that would suggest the claimed combination. *see In re Lee*, 61 USPQ2d 1430, 1433-1435 (Fed. Cir. 2002). Unspecified common sense and common knowledge is not sufficient for obviousness. *see id.* The Patent Office is obligated to develop an evidentiary basis for its findings. *See id.*

The Examiner has not provided concrete evidence to support his assertions that a grating fabricated above the top reflector is an obvious matter of design choice. Nor has he provided a specific principle or objective teaching to suggest the claimed combination of claim 26. Therefore, claim 26 is not obvious over Magnusson *et al.*

Claim 26, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 26 is respectfully requested.

27. Claim 26 was rejected under 35 U.S.C. 103(a) as being unpatentable over Hanke *et al.* Applicants respectfully disagree. The arguments regarding the anticipation of claim 1, upon which claim 26 depends, are incorporated herein.

As discussed above, claim 1, upon which claim 26 depends, is not anticipated by Hanke *et al.* Similarly, claim 1 is not obvious over Hanke *et al.* Hanke *et al.* discloses a light emitting diode (LED) which emits incoherent light in a broad spectral range. No means to provide emission of light in one resonant optical mode is taught or suggested. Hanke *et al.* does not teach or suggest a cavity and an active region designed such that any of the optical modes is a resonant optical mode. Therefore, claim 1 is not obvious over Hanke *et al.*

Regarding claim 26, the Examiner admits that Hanke *et al.* does not teach a grating fabricated above the top reflector, where the grating provides a distributed feedback in a lateral direction. However, the Examiner continues by stating it would be an obvious matter of design choice to any known element in the art that provides a distributed feedback in a lateral direction. The Examiner provides no support for this statement. Instead, the Examiner states that "applicant has not disclosed that a grating fabricated above the top reflector solves any stated problem or is for any particular purpose and it appears that the invention would perform equally well with the top reflector being partially etched." (present office action dated November 20, 2003, page 11, lines 13-16).

In the United States, the standard of obviousness has no relation to whether or not the elements claimed solved any stated problem or is for any particular purpose. Even if the invention would perform equally well with the top reflector being partially etched (which the Applicants do not concede), that is irrelevant to whether or not claim 26 is obvious. Claim 26 is a dependent claim, which adds a limitation to claim 1, upon which it depends.

In order for the Examiner to make a valid argument for obviousness, he must show that the reference or references, alone or in combination, teach or suggest all of the elements in the claim. The Examiner admits that Hanke *et al.* does not teach or suggest the elements of claim 26.

"The deficiencies of the cited references cannot be remedied by... general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art.... With respect to core factual findings in a determination of patentability,... the... [Examiner] cannot simply reach conclusions based on its own understanding or experience – or on its assessment of what would be basic knowledge or common sense. Rather, the... [Examiner] must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 59 USPQ2d 1693, 1697 (Fed. Cir. 2001).

In addition, the Federal Circuit has held that the Examiner must identify the specific principle or objective teaching that would suggest the claimed combination. *See In re Lee*, 61 USPQ2d 1430, 1433-1435 (Fed. Cir. 2002). Unspecified common sense and common knowledge is not sufficient for obviousness. *See id.* The Patent Office is obligated to develop an evidentiary basis for its findings. *See id.*

The Examiner has not provided concrete evidence to support his assertions that a grating fabricated above the top reflector is an obvious matter of design choice. Nor has he provided a specific principle or objective teaching to suggest the claimed combination of claim 26. Therefore, claim 26 is not obvious over Hanke *et al.*

Claim 26, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations it contains. Reconsideration and withdrawal of the rejection of claim 26 is respectfully requested.

Double Patenting Rejection

29. Claims 29-57 and 64-73 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-54 of U.S. Patent No. 6,611,539. Applicants respectfully disagree.

The Applicants respectfully suggest that this rejection is improper. Claims 29-57 and 64-73 are dependent claims, and must be viewed as a whole, with the claims upon which they depend. These claims can not be obvious over claims 1-54 of U.S. Patent No. 6,611,539 if the claims upon which they depend are not obvious over those claims.

Regarding claim 1, upon which claims 29-57 and 64-73 depend, the amended claim includes, in part, "c) a cavity located between the bottom reflector and the top reflector comprising an active region located within the cavity, **wherein the cavity and the active region are designed such that light in a resonant optical mode propagates in the cavity in a direction tilted with respect to both a direction normal to a lateral plane and the lateral plane itself.**"(Emphasis added).

Claims 1-54 of U.S. Patent 6,611,539 do not include a cavity and an active region designed such that light in a resonant optical mode propagates in the cavity in a direction tilted both normal to a lateral plane and with respect to the lateral plane itself. Claim 1 of the present application does not read on claims 1-54 of U.S. Patent No. 6,611,539, and does not encompass the same scope and limitations of U.S. Patent No. 6,611,539. Therefore, claim 1 is nonobvious and patentably distinct over claims 1-54 of U.S. Patent 6,611,539.

Claims 29-57 and 64-73, being dependent upon and further limiting claim 1, should also be allowable for that reason, as well as for the additional recitations they contain. Reconsideration and withdrawal of the rejection of claims 29-57 and 64-73 is respectfully requested.

Conclusion

Applicant believes the claims, as amended, are patentable over the prior art, and that this case is now in condition for allowance of all claims therein. Such action is thus respectfully requested. If the Examiner disagrees, or believes for any other reason that direct contact with Applicants' attorney would advance the prosecution of the case to finality, he is invited to telephone the undersigned at the number given below.

> "Recognizing that Internet communications are not secured, I hereby authorize the PTO to communicate with me concerning any subject matter of this application by electronic mail. I understand that a copy of these communications will be made of record in the application file."

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